XI. *A Contribution to our knowledge of the Life-history of the Stick Insect*, Carausius morosus *Br.* By George Talbot, F.E.S.

[Read March 17th, 1920.]

Synopsis.

1. Introduction.

The observations here set forth were made during the years 1910, 1911, and 1912. They were carried out under various difficulties, and are not so thorough nor so extensive as those given to the entomological world by Mr. H. Ling Roth in his exhaustive paper published in these Transactions for 1916, p. 345. My results are not entirely the same, but the conditions under which the insects were reared were different. The most striking difference is seen in the number of moults; in most cases only three were observed and four on only two occasions, never five nor six.

I do not give here any notes on the mode of oviposition, emergence from the egg, and general habits, which differ in no particular from the observations made by Roth.

The specimens were kept in wooden boxes fitted with glass on one side and perforated on another side to admit plenty of air. These were stood on end on small receptacles containing water into which the stem of the food-plant was placed. The insects were fed on privet. [*Cont. on p.* 293.]

2. GENERAL LIFE-HISTORIES.

	Parent A.	Parent B.	Generation B1. Specimen 1.	Generation B1. Specimen 2.	Parent C.	Generation C1.
Date when egg was deposited by parent.	—	—	17.viii.'11.	8.ix.'11, 5–11 p.m.	—	28.viii.'11, 3–5 p.m.
Date of hatching.	Between 2.v.'11 and 3.v.'11.	13.xii.'10.	16.iv.'12, a.m.	28–29.v.'12.	27.xi.'10.	3.v.'12.
Period of incubation.	—	—	242 days.	262 days.	—	248 days.
1st ecdysis.	12–14.viii.'11. Only skin of one leg found.	30–31.iii.'11.	1.vi.'12.	Between 25.vi.'12, 7 p.m., and 26.vi.'12, 6 p.m.	18–24.v.'11.	13–15.vi.'12.
2nd ecdysis.	1–2.ix.'11.	1–7.vi.'11.	13.vii.'12.	28–30.vi.'12.	17–27.vi.'11.	1–6.vii.'12.
3rd ecdysis.	22–25.x.'11.	1–7.vii.'11.	1–3.viii.'12.	17–20.ix.'12.	13–20.vii.'11.	7–8.ix.'12.
4th ecdysis.	Not observed.	Not observed.	Not observed.	Not observed.	Not observed.	Not observed.
Commencement of oviposition.	12–19.i.'12.	15.viii.'11.	About 20.viii.'12.	About 4.xii.'12.	12.viii.'11.	Not observed.
Period of post-embryonic development.	257 days.	245 days.	126 days.	189 days.	258 days.	Not known.
Rate of oviposition.	14–19.i., one; 19–22.i., one; 23.i., none; 25.i., two; hereafter an average of one per day.	First 20 days, 40. Average from Aug.–Oct., 1–2 per day; from Nov.–Jan., one in 2 days.	3–9.ix., 15; 9–20.ix., 19; 20.ix.–13.x., 44; 13.x.–9.xi., 44; 9.xi.–8.xii., 32.	8.xii.'12 to 23.iii.'13, 50.	First 20 days, 46; Sept. and Oct., average 2 in 3 days; Nov. to Jan., one in 2 days.	8.xii.'12 to 23.iii.'13, 86.
Period of oviposition.	325 days.	445 days.	Not known.	Not known.	286 days.	Not known.
Total number of eggs.	436.	456.	Exceeding 150.	Not known.	486.	Not known.
Age of specimen at death.	About 580 days.	692 days.	Not known.	About 312 days.	554 days.	Not known.

	Parent D.	Generation D1. Specimen 1.	Generation D1. Specimen 2.	Parent E.	Generation E1. Specimen 1.	Generation E1. Specimen 2.
Date when egg was deposited by parent.	—	17.viii.'11. 9.30 a.m.–6 p.m.	22.viii.'11. 2–6 p.m.	—	20.viii.'11. 7–10 p.m.	10.ix.'11. 6–12 p.m.
Date of hatching.	13.xii.'10.	24.iv.'12.	26.iv.'12.	14.xii.'10.	1.v.'12.	27.v.'12.
Date of incubation.	—	248 days.	247 days.	—	254 days.	254 days.
1st ecdysis. 2nd ecdysis.	28.vi.–24.vii.'11. Not observed.	4–8.vi.'12. 25–26.vi.'12.	19.v.'12. 8.vi.'12.	7–17.vi.'11. 13–20.vii.'11.	11–17.vi.'12. 16.vii.'12. Not complete.	19–22.vii.'12. 17–24.viii.'12.
3rd ecdysis.	Not observed.	10.viii.'12. Observed only skin of legs, two being complete.	12–16.ix.'12. A portion only found.	Not observed.	8.viii.'12.	13–16.ix.'12.
4th ecdysis.	Not observed.	7–8.ix.'12.	Not observed.	Not observed.	Not observed.	Date uncertain, but found a cast on 4.xi.'12.
Commencement of oviposition.	19.viii.'11.	About 5.x.'12.	About 1.x.'12.	9.viii.'11.	About 30.ix.'12.	About 1.xii.'12.
Period of post-embryonic development.	249 days.	164 days.	157 days.	238 days.	153 days.	188 days.
Rate of oviposition.	First 20 days, 43; average for Sept. and Oct., 3 in 2 days; from Nov.–Jan., one in 2 days.	First 8 days, 12; Oct. 13–Dec. 8, 62; Dec. 8–Mar. 23, 84.	5–13.x., 10; 13.x. to 8.xii., 62; 8.xii. to 23.iii., 80.	First 20 days, 32; average for Sept. and Oct., 2 in 3 days; Nov. to Jan., one in 2 days.	Sept. 30–Oct. 5, 23; 5–13.x., 8; 13.x.–8.xii., 79; 8.xii.–23.iii., 97.	Between 8.xii. and 23.iii., 57.
Period of oviposition.	148 days.	Not known.	Exceeding 500 days.	447 days.	Exceeding 316 days.	Exceeding 400 days.
Total number of eggs.	139.	Not known.	Not known.	458.	Not known.	Not known.
Age of specimen at death.	About 401 days.	Exceeding 500 days.	629 days.	685 days.	Exceeding 470 days.	Exceeding 467 days.

DESCRIPTIONS OF SPECIMENS.

Parent A.	At first green, but later changed to pale buff speckled with black.
Gen. A1.	33 specimens were bred. All these, with exception of one tinged with reddish-brown, were light green.
Parent B.	At first green, but later changed to earth-brown with a dorsal patch of pale buff on the fourth abdominal segment.
Gen. B1.	
Spec. 1.	June 1st, after first ecdysis.—Pale yellowish-green.
	July 13th, after second ecdysis.—Colour unchanged.
	Aug. 3rd, after third ecdysis.—Colour unchanged.
	Dec. 8th.—Green. Mesothorax below pinkish, abdomen below paler green.
Spec. 2.	July 30th, after second ecdysis.—Dark earth-brown with a slight tinge of green. Skin wrinkled and rugose.
	Sept. 20th, after third ecdysis.—Darker and without green tinge.
	Dec. 8th.—Very dark earth-brown; ventral surface, except of mesothorax, paler.
	April 6th.—Nearly black. Abdomen with a pale lateral stripe, mesothorax paler below.
Gen. B2.	
Specs. 1–10.	Light green, underside pale yellow; a more or less distinct orange spot at base of metasternum; base of anterior femora on inside faintly reddish.
Spec. 11.	Speckled with brown; thorax more rugose than in the others.
Specs. 12–13.	Dark green. Thorax rugose. Base of anterior femora reddish. Below paler green and speckled with yellow.
Parent C.	Green.

Gen. C1.	
Spec. 1.	June 4th.—Pale dirty green with dark lateral stripes, and two dorsal stripes of dark brown on head and thorax; abdomen not striped.
	June 15th, after first ecdysis.—Colour unchanged.
	July 6th, after second ecdysis.—Colour unchanged.
	Sept. 8th, after third ecdysis.—Grey, with a faint pink tinge, and speckled with bluish-black markings; ventral surface paler. Wart-like points numerous, black, tipped with grey. Legs and head below sea-green, the legs paler and much speckled.
	Dec. 8th.—Uniformly pale ochreous with a pink tinge and speckled with black points.
	April 6th.—Colour unchanged except that the abdomen bears a rusty-brown lateral stripe.
	Sept. 7th.—Colour unchanged except that the abdominal stripe is absent and abdomen paler below.
Gen. C2.	
Spec. 1.	Pale green above, pale yellowish-brown below.
Spec. 2.	Pale ochreous tinged with green, pale brown below. Legs dark green.
Specs. 3–5.	Pale ochreous tinged with green.
Parent D.	Green. Abdomen almost smooth with few granulations. Head and thorax closely granulated.

DESCRIPTIONS OF SPECIMENS.

Gen. D1. Spec. 1.	June 4th.—Pale green.
	June 8th, after first ecdysis.—Yellowish-green.
	June 26th, after second ecdysis.—Legs green, spotted with black; antennae greyish. Above: Head and pronotum light green with some black spots; thorax yellowish-green marked with black spots and dark dorsal areas of green; abdomen yellowish-green, joints of segments marked with black spots; head and thorax with small wart-like projections, the larger of which are black. Underside paler.
	Aug. 10th, after third ecdysis.—Colour much darker. Ground-colour olive-green mottled with brown. Increase of wart-like projections which are sparsely distributed over the abdomen. Underside grey, metathorax darker. General colour a greyish-green.
	Sept. 8th, after fourth ecdysis.—Colour darker, a dirty brown. Differs chiefly from preceding stage in the whole ventral and under surface being coloured as the upper. Legs spotted with yellowish-green.
	Dec. 8th.—Colour earth-brown with greenish and pinkish mottlings. Underside of mesothorax reddish, and abdomen with a reddish lateral stripe.
	April 6th.—Almost black with pale greenish and yellowish mottlings. Underside of mesothorax pale brown.
	Sept. 7th.—Colour unchanged.

D1.	
Spec. 2.	June 4th, after first ecdysis.—Pale green.
	Sept. 16th, after third ecdysis.—Ochreous, no green tint present.
	Dec. 8th.—Pale ochreous with faint pink tinge. Lower surface of mid-femora orange, of anterior femora scarlet at base. Under surface of mesothorax paler. Abdomen with lateral reddish stripe, and ventral surface more speckled than the dorsal.
	April 6th.—Colour unchanged.
	Sept. 7th.—Colour much darker.
Spec. 3.	Light yellowish-green, paler below.
Spec. 4.	Dark green. Thorax somewhat rugose. Underside paler and yellowish.
Gen. D2.	
Specs. 1–8.	Pale green tinged with yellow.
Spec. 9.	Dark green. Thorax somewhat rugose. Underside pale and yellowish.
Parent E.	Dark olive-green. The fourth abdominal segment bears a dorsal patch of pale buff.
Gen. E1.	June 4th, before first ecdysis.—Wholly pale green, but legs and antennae with little colour, last segment of antennae distinctly brownish.
	Aug. 8th, after third ecdysis.—Colour unchanged except that the abdomen bears a dark lateral stripe.
	Sept. 7th.—Colour unchanged.

DESCRIPTIONS OF SPECIMENS.

E1.	
Spec. 2.	May 27th, after emergence from egg.—Ground-colour pale greenish-yellow, mottled strongly with brown.
	July 27th, after first ecdysis.—Colour more greenish.
	Aug. 24th, after second ecdysis.—Pale ochreous, ventral surface light grey.
	Sept. 16th, after third ecdysis.—Colour a little darker.
	Nov. 9th, after fourth ecdysis.—Colour unchanged.
	Dec. 8th.—Head and thorax earth-brown, metathorax and abdomen pale ochreous. Thorax below dark reddish-brown; anterior and intermediate legs same colour as thorax, posterior legs same colour as abdomen; under surface of intermediate femora orange near base, of anterior femora scarlet near base.
	April 6th.—Colour unchanged.
	Sept. 7th.—Abdomen darker, only slightly paler than thorax.
Gen. E2.	
Specs. 1–5.	Colour light green.
Spec. 9.	Pale ochreous tinged with green.

The boxes were kept in a room without artificial heating. During some periods of cold weather the temperature of the room must have been below 40° F.

Roth kept his insects in inverted glass bell-jars in a room maintained at a certain temperature. It is certain that the temperature inside his bell-jars was higher than outside, but only the room temperature is given.

The eggs for incubation were kept in ordinary chip boxes in the room with the insects, and no moisture was given them.

3. Egg Development.

An egg is deposited at intervals of from 4 to 6 hours, but during an interval of 96 hours only from 8 to 10 are deposited. There are intervals of 20 to 40 hours during which none are laid, and it is during this time that others are developed for deposition at further intervals of from 4 to 6 hours. It would appear that 8 to 10 eggs are developed at one time though at different stages, so that when one is laid another is beginning to form.

During 96 hours there is altogether an interval of from 40 to 60 hours during which none are laid, and the longer the interval the fewer are laid. However the interval of rest may vary, the number of eggs laid is still one for every period of 4 to 6 hours.

In one case, during 96 hours 10 eggs were deposited with a total rest interval of 42 hours. In another case, during 96 hours 6 eggs were deposited with an interval of 56 hours.

A lengthened period of rest does not result in the development of more eggs. One egg in each ovarian tube is ready almost at the same time, the succeeding egg being far behind in development. As soon as these ripe eggs have been discharged, the period of rest supervenes until the next batch is ready.

Eggs were mostly deposited between the hours of 6 p.m. and 10 a.m.

Eggs are deposited at less frequent intervals from the age of 320 to 400 days, and these intervals increase in length until on the average half the number of eggs is produced in the same time.

The egg is visible within the anal cavity several hours before it is dropped.

4. VARIATION IN EGGS.

Specimen.	No. of the egg in series depos.	Peculiarity.
A.	7th	Small. The knob scarcely projects from its cavity, being almost flat.
	8, 9, 10	The knob is conical.
	14–37	Includes 3 small ones.
	38–47	One is smaller than usual, of a reddish-brown colour, and with conical knob.
	53–61	Two of these are small.
	257–316	One of these is only about size of a pin's head, and very dark in colour. Cap nearly normal size.
B.	154–157	One small one.
	160	Slaty-grey in colour. Knob flatter than usual.
	161–164	The knob of these is conical.
	221–246	A few of these are very small.
	443–455	One of these is only about size of a pin's head.
C.	177–179	One rather small.
	229–252	A few of these are very small.

The data contained in the general life-histories is displayed and summarised in the following tables, 5–15.

5. PERIOD OF INCUBATION OF THE EGG.

Specimen.	Date of Deposition of Egg.	Date of Emergence.	Period of Incubation. Days.
B1. Gen. 1.	17.viii.	16.iv.	242
B2. Gen. 1.	9.ix.	28–29.v.	262
C1. Gen. 1.	28.viii.	3.v.	248
D1. Gen. 1.	17.viii.	24.iv.	250
D2. Gen. 1.	22.viii.	26.iv.	247
E1. Gen. 1.	20.viii.	5.v.	254
E2. Gen. 1.	9.ix.	27.v.	229

It will be seen from this table that the data was obtained in respect of eggs which necessarily passed a period of their development during the winter months. The average period of incubation obtained under these conditions is 247 days. The observations of Mr. Roth, *l. c.*, who kept his eggs at a temperature ranging from 56° F.–64° F., show a period of 137–297 days for incubation under those conditions.

6. PERIOD OF INCUBATION OF TWO OR MORE EGGS DEPOSITED WITHIN 24 HOURS.

No. of Eggs Laid.	Date when Eggs were Laid.	Date of Hatching of			Approximate Period of Incubation. Days.	Range. Days.
		First Egg.	Second Egg.	Third Egg.		
3	11 p.m. 26.viii.'11–11 p.m. 27.viii.'11.	25.iv.'12.	26.iv.'12.	26.iv.'12.	244–245	1
2	6 p.m. 22.viii.'11–10.30 p.m. 23.viii.'11.	27.iv.'12.	30.iv.'12.	—	247–250	3
3	6.30 p.m. 25.viii.'11–10·30 a.m. 26.viii.'11.	5.v.'12.	9.v.'12.	17.v.'12.	253–265	12
2	6–10 p.m. 29.viii.'11.	13.v.'12.	14–16.v.'12.	—	258–261	3
2	6–9.30 p.m. 1.ix.'11.	13.v.'12.	14–16.v.'12.	—	255–258	3
2	2–3.ix.'11.	14–16.v.'12.	19.v.'12.	—	256–260	4
2	5–12 p.m. 7.ix.'11.	20–23.v.'12.	7.vi.'12.	—	257–273	16
3	6–12 p.m. 10.ix.'11.	24–26.v.'12.	27.v.'12.	—	259–261	2
2	5–11 p.m. 8.ix.'11.	28–29.v.'12.	9.vi.'12.	—	264–275	11
4	5–12 p.m. 7.ix.'11.	9.vi.'12.	12.vi.'12.	—	276–279	3
6 Deposited by 3 specs.	2–3.ix.'11.	20–23.v.'12.	20–23.v.'12.	20–23.v.'12.	261–263	2
3	15.viii.'11.	6.iv.'12.	14.iv.'12.	—	235–243	8

7. THE ECDYSES.

(Figures in brackets indicate day counted to or from.)

Spec. No.	Date of Hatching.	1st Ecdysis.	2nd Ecdysis.	3rd Ecdysis.	Days between Hatching and 1st Ecdysis.	Days between 1st and 2nd Ecdysis.	Days between 2nd and 3rd Ecdysis.	Age at 3rd Ecdysis.
B.	13.xii.	30–31.iii. (30).	1–7.vi. (4).	1–7.vii. (4).	107	66	30	203
B1.	16.iv.	1.vi.	13.vii.	1–3.viii. (2).	45	42	20	107
B2.	28–29.v. (28).	25–26.vi. (25).	28–30.vii. (28).	17–20.ix. (18).	28	34	20	82
C.	27.xi.	18–25.v. (21).	17–27.vi. (21).	13–20.vii. (16).	175	31	25	231
C1.	3.v.	13–15.vi. (14).	1–6.vii. (3).	7–8.ix.	42	19	66	127
D.	13.xii.	28.vi.–4.vii.(30.vi.).	Not seen.	Not seen.	199	—	—	199
D1.	24.iv.	4–8.vi. (4).	25–26.vi.	10.viii. 4th ecdy., 7–8.ix.	41	51	46 3rd–4th, 28.	138 At 4th, 166.
D2.	26.iv.	19.v.	8.vi.	12–16.ix. (14).	23	20	98	141
E.	14.xii.	7–17.vi. (12).	13–20.vii. (16).	Not seen.	180	34	—	214
E1.	1.v.	11–17.vi. (14).	16.vii.	8.viii.	44	32	23	99
E2.	27.v.	19–22.vii. (20).	17–24.viii. (20).	13–16.ix. (14). 4th ecdy., 9.xi.	54	31	25 3rd–4th, 56.	110 At 4th, 166.
A.	2–3.v. (2).	12–14.viii. (13).	1–2.ix. (1).	22–23.x. (22).	103	19	52	174
				Average . .	86	34	10	152

8. SUMMARY OF MOULTING PERIODS.

Time of Development between	Days.	Range in Days.
Hatching and 1st ecdysis.	23–199	176
1st and 2nd ecdysis.	19–66	47
2nd and 3rd ecdysis.	20–98	78
3rd and 4th ecdysis.	28–56	28
Age at 3rd ecdysis.	82–214	132
Age at 4th ecdysis.	166	0

9. OVIPOSITION.

Specimen.	Period of Oviposition Days.	No. of Eggs produced.	Rate of Deposition.		
			First 20 Days.	First 2 months.	Second 3 Months.
B.	445	486	10	1–2 per day	1 in 2 days
C.	286	313	46	2 in 3 days	1 in 2 days
E.	447	458	22	2 in 3 days	1 in 2 days
A.	325	436	—	1 per day	1 per day
D.	148	139	43	3 in 2 days	1 in 2 days
B2.	—	—	50	in 3 months.	
Average	330	366	37	1 per day.	1 in 2 days

10. POST-EMBRYONIC DEVELOPMENT AND LONGEVITY.

Specimen.	Date of Emergence from Egg.	Date of 3rd Ecdysis.	Oviposition commenced.	Approximate Period between 3rd Ecdysis and Oviposition.	Approximate Period of Post-embryonic Development.	Age at Death. Days.
A.	2–3.v.'11.	22–23.x.'11.	14–19.i.'12.	86	257	580
B.	13.xii.'10.	1–7.vii.'11.	15.viii.'11.	42	245	692
B1.	16.iv.'12.	1–3.viii.'12.	About 20.viii.'12.	18	126	Above 229
B2.	28–29.v.'12.	17–20.ix.'12.	About 4.xii.'12.	77	189	About 312
C.	27.xi.'10.	13–20.vii.'11.	12.viii.'11.	27	258	551
D.	13.xii.'10.	28.vi.–4.vii. (Only one observed)	19.viii.	50	249	401
D1.	24.iv.'12.	7–8.ix.	About 5.x.	28	161	Above 500
D2.	26.iv.'12.	12–16.ix.	About 1.x.	17	157	629
E.	14.xii.'10.	13–20.vii. (Second and last seen)	9.viii.	24	238	685
E1.	1.v.'12.	8.viii.	About 30.ix.	53	153	Above 470
E2.	27.v.'12.	9.xi. (IIIth ecdysis)	About 1.xii.	22	188	Above 467
Average				40	202	501

11. RATE OF GROWTH.

Specimen.	1st Ecdysis.		2nd Ecdysis.		3rd Ecdysis.		Maximum Length attained. Mm.	Increase between 1st and 2nd Ecdysis. Mm.	Increase between 2nd and 3rd Ecdysis. Mm.	Age when Maximum Length attained. Days.
	Age. Days.	Length. Mm.	Age. Days.	Length. Mm.	Age. Days.	Length. Mm.				
B1.	46	29	88	31	108	70	75	2	39	351
B2.	28		61	—	113	55	70			342
C1.	42	24	61	29	127	35	77	8	6	223
D1.	11	27	62	36	108	62	80	9	26	147
D2.	23	19	43	27	111	71	78	8	47	Above 345
E1.	11	24	76	11	99	57	75	20	13	253
E2.	54	38	85	16	110	60	76	8	11	191
Average	39·7	26·3	68	35·5	115·1	59	75·8	9·1	24·1	261

12. MEASUREMENTS AT MAXIMUM GROWTH.

(Made on living specimens.)

Specimen.		Head. Mm.	Prothorax. Mm.	Mesothorax. Mm.	Metathorax. Mm.	Abdomen. Mm.	Total Length.	Femora.		
								Anterior. Mm.	Intermediate. Mm.	Posterior. Mm.
B1.	1st Gen.	4	4	17	12	38	75	17	12	15
B2.	1st Gen.	3·5	3·5	16	11	36	64	16	12	14
C1.	1st Gen.	4	4	17	12	40	77	16	12	14
C1.	2nd Gen.	3	3	16	11	35	68	14	10	13
C2.	2nd Gen.	3·5	3·5	17	11	36	70	15	11	13
C3.	2nd Gen.	4	4	17	12	38	75	15	11	13
C4.	2nd Gen.	4	4	17	11	35	74	15	10	13
C5.	2nd Gen.	4	4	17	12	40	77	17	13	15
E1.	1st Gen.	4	4	16	11	38	73	16	11	14
E2.	1st Gen.	4	4	17	12	40	77	17	13	15
E1.	2nd Gen.	4	4	17	11	32	68	15	11	14
D1.	1st Gen.	4	4	18	12	42	80	17	12	15
D1.	2nd Gen.	3·5	3·5	16	11	35	69	14	11	13
D2.	2nd Gen.	4	4	17	11	33	69	15	13	14
D3.	2nd Gen.	4	3	17	11	35	70	15	11	13
D4.	2nd Gen.	3	3	17	11	36	70	16	11	13
D5.	2nd Gen.	4	4	17	11	36	72	15	10	13
Average .		3·7	3·7	16·8	11·3	36·1	71·7	15·1	11·2	13·5

13. CHANGES IN COLORATION.

Spec.	Newly-hatched.	After 1st Ecdysis.	After 2nd Ecdysis.	After 3rd Ecdysis.	If a Change later.
B1.	Not recorded.	Pale yellowish-green.	Unchanged.	Unchanged.	Yes.
B2.	Not recorded.	Not recorded.	Dark brown with greenish tinge.	Darker, no green tinge.	Yes.
C1.	Pale dirty green.	Unchanged.	Unchanged.	Grey, with pink tinge and speckled with bluish-black.	Yes.
E1.	Pale green.	Not recorded. Probably unchanged.	Not recorded. Probably unchanged.	Abdomen with a dark lateral stripe.	No.
E2.	Pale greenish-yellow mottled with brown.	More greenish.	Pale ochreous.	A little darker.	Yes.
D1.	Pale green.	Yellowish-green.	Yellowish-green with black speckling.	Dark green mottled with brown.	Yes.
D2.	Not recorded.	Pale green.	Not recorded.	Ochreous.	Yes.

14. COLORATION AT THE FINAL STAGE.

Illustrating Variation in same Generation.

Parent.	Colour of Parent.	Offspring of 1st Gen.		Period over which Colour has changed in 1st Gen.	Offspring of 2nd Gen.	
B.	Earth-brown. A dorsal patch of pale buff on 4th abdominal segment.	Specs. 1	Green.	8 months.	Specs. 1 to 10	Green.
		2	Nearly black; abdomen with pale lateral stripe.	10 months.	11	Green, speckled brown.
					12, 13	Darker green.
C.	Green.	1	Pale ochreous with pink tinge and speckled black.	16 months.	1	Pale green above. Pale yellowish-brown below.
					2 to 5	Pale ochreous tinged with green.
D.	Green. Abdomen nearly smooth.	1	Nearly black with greenish and yellowish mottlings.	11½ months.	1 to 8	Yellowish-green.
		2	Dark ochreous.	16 months.	9	Dark green.
		3	Yellowish-green.			
		4	Dark green.			
E.	Dark green.	1	Pale green.	16 months.	1 to 8	Light green.
		2	Earth-brown. Abdomen a little paler than head and thorax.	15½ months.	9	Pale ochreous.

15. SUMMARY OF TABLES.

Incubation.	Average period.		247 days.
	Variation in range of two or more eggs deposited in 24 hours.		1–16 days.
Ecdyses.	Average period between	Hatching and 1st ecdysis.	86 days.
		1st and 2nd ecdysis.	34 days.
		2nd and 3rd ecdysis.	40 days.
	Average age at	3rd ecdysis.	152 days.
		4th ecdysis.	166 days.
Oviposition.	Average period.		330 days.
	Average number of eggs.		366.
	Average number of eggs during	First 20 days.	37.
		First 2 months.	One per day.
		Second 3 months.	One in 2 days.
Post-embryonic development.	Average time between 3rd ecdysis and oviposition.		40 days.
	Period of post-embryonic development.		202 days.
Longevity.	Average age reached.		501 days.
Rate of growth.	1st ecdysis.	Average age.	39·7 days.
		Average length.	26·3 mm.
	2nd ecdysis.	Average age.	68 days.
		Average length.	35·5 mm.
	3rd ecdysis.	Average age.	115 days.
		Average length.	59 mm.
	Average increase between	1st and 2nd ecdysis.	9·1 mm.
		2nd and 3rd ecdysis.	21·1 mm.
	Average maximum length reached.		75·8 mm.
	Average age at maximum length.		261 days.
Average measurements at maximum growth.	Head.		3·7 mm.
	Prothorax.		3·7 mm.
	Mesothorax.		16·8 mm.
	Metathorax.		11·3 mm.
	Abdomen.		36·4 mm.
	Total length.		71·7 mm.
	Femora.	Anterior.	15·4 mm.
		Intermediate.	11·2 mm.
		Posterior.	13·5 mm.

16. The Reconstruction of a Lost Limb.

Having read that Stick Insects are capable of growing a new limb in the event of one being lost under certain conditions, I made the following experiment :—

Posterior right leg removed at trochanter when 1 *day old.*

Age 28 days.—A miniature limb has developed in place of the lost one. It is about a third the size of normal, and is almost colourless.

Age 45 days.—The new limb is about two-thirds the size of normal. The fourth tarsal segment is rudimentary.

Age 62 days.—Upon completion of first ecdysis.—There is no apparent change in the form of the new limb.

No further experiments were made, but there is room for much more work on this subject.

17. Simulation of Death in the Newly-hatched.

On several occasions, upon removing cover from boxes in which insects had hatched a few hours previously, they were seen to draw up the legs and antennae and instantly assume the characteristic attitude of an adult specimen.

18. Mortality.

A certain proportion of individuals in any batch hatched always died at an early stage from no apparent cause. A few would show abdominal malformations after attaining maturity, and such individuals were not usually long-lived.

Mortality from unknown causes was exhibited in batches reared in the same cage or box. This pointed to some inherent weakness in the individual, a factor of probable importance in reducing the numbers of many species of insects. The insect may be less resistant to the attacks of bacteria and more sensitive to changes of temperature, etc.

19. Variation and Parthenogenesis.

The high degree of protective resemblance exhibited by Stick Insects is probably the result of severe competition in the struggle for existence. A further protection is given to the species by the power of parthenogenetic reproduction.

The great degree of variation shown to exist in these

insects has rendered possible their protective coloration and instincts. This may be ancestral to the parthenogenetic condition, which would seem to have been developed in response to continued competition. This would suggest that the immunity obtained through instinct and coloration was at some period weakened by the introduction of another destructive factor in the environment.

20. Inheritance of Variability.

In the various factors dealt with in the preceding tables, the offspring may differ widely from the parent in one or two generations. Neither do the individuals of one generation exhibit any agreement in these factors, except in the case of size, which is fairly constant throughout, and probably of specific peculiarity.

July 26, 1920.